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The Effects of Robotics on Fully Residential School Students' Science Process Skills

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Abstract--- *Recently, using robotics in school education as innovation in learning and instructional for teaching purpose has become one of the main concerns among researchers. Robotics in education provides a way of learning that seems to be particularly attractive to students who are struggling with conventional school methods. Therefore, this research proposes an approach to use robotics as a tool to enhance science process skills which is one component of scientific skills. As a result, research related to the Quality Answers SPM in Physics in Malaysian Certificate of Education student which show the level of students' achievement is low. The aim of this study is to investigate the impact of using robotics in science process skills among Fully Residential School student. In this research, constructivist methodologies for integrating robotics in kinematics in Physics class are suggested. The instrument used in this study is Integrated Process Skills Test II, a paper and pencil multiple-choice test to measure the acquisition of the integrated science process skills. This paper explains how the robotics positively changed the effect. Thus, efforts to increase the level of science process skills should be taken to produce individual who are excellent in Science and Mathematics.*

Keywords--- *Robotics, Physics Education, Science Process Skills.*

I. INTRODUCTION

The rapid development of technology such as robotic certainly offers huge opportunities to be implanted in education. Robotics means a process field involving automobile-operated electrical and mechanical (mechatronic) equipment (Mathers, Goktogen, Rankin, & Anderson, 2012). In fact, robotic research projects in education have begun in the 1980s, conducted among others in including Greece, Italy, Spain, France, Romania and the Czech Republic. The implementation took place in the classroom environment of primary, secondary and tertiary education levels (Andruseac & Adascalitei, 2014). Robotic advantages include integrating learning and training in science, engineering, and encouraging creative thinking (Chung & Cartwright, 2011). Observing the goodness and potency of this technology, various efforts have been made to improve the existing pedagogy by implementing robotics.

However, the priority of implementing robotic in education should be parallel with the 21st century learning system (PAK-21). This intention should be carefully planned (Alimisis, 2012) and executed in line with the one of

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Malaysia's aspirations as documented which is to nurture science and technology oriented society. Indeed, this initiative has been implemented on some schools. This situation is acknowledged when the administration and management of fully residential school have taken proactive step towards providing a well-organized, controlled and technologically-oriented schooling and learning environment (Muhammad Faizal et al., 2013). It is such an effort to nurture and develop the potential of outstanding students as a balanced citizen to become scientists, technocrats and professionals who can accomplish the National aspirations (Ministry of Education, 2015).

Furthermore, in the effort to apply robotics in teaching and learning, the selected course is Physics for SPM specifically on Chapter Force and Motion. Based on interviews with experienced teachers who have been teaching more than 15 years, as well as literature studies on robotics, several factors have been appointed. The first factor is regarding the largest number of practical exercise in Physics course; there are 10 of them on Chapter Force and Motion alone. Based on the analysis on Physics Paper 2 and Paper 3 SPM 2003-2008, 21.6% of the questions, which is also the highest, are about force and motion. It can be summarized that the higher the practical number, the students have a higher opportunity to achieve higher grades in the exam (Zurida, Mohd, & Ahmad, 2005). For the second factor, students frequently encounter misconception when learning this topic (Rohana Mohd Atan & Shaharom Noordin, 2008). The third factor, until today, when teaching Force and Movement, the same dull conventional equipment (e.g. trolley) and computer aids (e.g. computer simulations) are utilized. The fourth factor, Chapter Force and Movement is the foundation of Physics course that measure the achievement and integrated science process skills (KPSB) in practical and written tests (Salawati Sahar & Fatin Alia Phang Abdullah, 2011).

The continuation of fourth factor shows that there is a significant relationship between the implementation of integrated science process skills and the achievement of students in which the more regular teachers organize activities and experiments, the higher the students' achievement (Stohr-Hunt, 1996). In fact, practically the students are able to answer test questions better, based on their mastery of the science process in practical work (Capp, 2009). Hence, the student's achievement is closely related to their mastery of integrated science process skills in practical work and school activities (Aktamis & Ergin, 2008). Likewise in Physics, integrated science process skills mastery of the students is also closely related to students' achievement in the subject (Rohana Mohd Atan & Shaharom Noordin, 2008).

Furthermore, based on the points identified from the above introduction, teaching and learning Physics making use of robotics as an alternative teaching aids tool (Goh & Mohamad Bilal Ali, 2014) will enhance integrated science process skills. Using conventional equipment, students only use the sense of vision and cognition (minds-on) on an object (abstract), whereas through the help of robotics, students will use visual, cognition and touch (hands-on) as an added value on the artificial material that will reinforce their understanding (Papert & Harel, 1991). Thus, this study will discuss the robotic effects of integrated science process skills of fully residential school students in Physics.

II. MATERIALS AND METHODS

The significance of selecting 33 Form for fully residential school students as the subject of study was that they were on a right path in pursuing their higher education level that later on would have careers in science and

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technology and play a role in national development (Curriculum Development Centre, 2005). In addition, comparative study is more focused on outstanding schools that have a centralized study system. In contrast, schools that offer different education streams do not have the same culture that might result in inappropriate findings for sharing (Muhammad Faizal et al., 2013).

To test the level of mastery of integrated science process skills, Integrated Process Skills Test II (TIPS II) was selected. This set of questionnaire consisted of 36 objective questions to evaluate the integrated science process skills that included developing hypotheses (7 questions), controlling variables (16 questions), defining operationally (7 questions), interpreting data (3 questions) and designing experiments (3 questions). TIPS II is constructed from (Burns, Okey, & Wise, 1984). This integrated science process skills test was administered after robotic intervention as teaching aids was implemented a week after the completion of this robotic exercise. This test was conducted for one hour. Table 1 shows the distribution of questions according to the tested integrated science process skills

Table 1: Distribution of Questions for each Skill

Integrated Science Process Skills	***Question Number***	***Quantity of Questions***
Controlling Variables	1, 2, 3, 5, 6, 11, 15, 16, 18, 19, 24, 26, 28, 29, 31, 34	16
Developing Hypothesis	4, 9, 14, 20, 25, 32, 35	7
Interpreting Data	7, 22, 23	3
Defining Operationally	8, 12, 13, 17, 23, 27, 30	7
Designing Experiments	10, 21, 36	3
Total Questions		36

Furthermore, the percentage of scores was used to determine the level of students' mastery in each skill element. Each item answered correctly was given one mark. Then the scores obtained were converted into a percentage for analysis purposes. Subsequently the classification system according to the level of mastery was carried out based on method of mastery 2/3 of 100 percent (Ong Eng Tek et al., 2012). Table 2 shows the classification system to determine the level of students' mastery of every element. When the score were 66.7% and above, the student was considered as "Mastering" the skill. On the other hand, when less the score was less than 66.7%, the student was considered to be "Not mastering" (incompetent) the skill (Tek & Mohamad., 2013). After that, the number of Mastering students will be tabulated for each skill. Comparisons of total numbers of students who were Mastering for pre and post-test were made for analysis purposes.

Table 2: Classification System to Determine the Level of Student's Mastery

Score percentage	***Level of mastery***
<66.7	Not mastering
≥66.7	Mastering

III. RESULTS

33 students were selected to be involved in the actual study. This study took into account both sexes representing each group. Therefore there was no gender bias in this study. This test is administered twice; pre-test and a post test. Pre-test was conducted a week before teaching and learning using robotics. Post-test was conducted a week after completion of teaching and learning using robotics. Once marking the test papers was completed, scores were grouped according to the type of skill. According to the marks, the classification was identified either Master or

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Non-Master using ≥66.7% as a benchmark (Tek & Mohd Al-Junaidi Mohamad, 2013). The number of students reaching Master level according to the type of skills was tabulated. Table 3 shows the summation of students who were in Master Level for pre and post-tests. The difference in the number of students reaching the Master level was also stated.

Table 3: Total of Mastery Level Student for Each Component

Integrated Scientific Process Skill	***Total of student (Mastery Level, ≥66.7%)***		**Differentiations**
	Pre-test	***Post-test***	
Identifying Variables	0	6	+6
Formulating Hypothesis	2	3	+1
Interpreting Data	5	9	+4
Defining Operationally	9	14	+5
Designing Investigation	16	18	+2

The highest improvement was the ability to identify the variables (six) followed by the Defining Operationally (five), Interpret Data (four), Designing Investigation (two) and Formulating Hypothesis (one). In conclusion, there was an increase in the number of students; 18 students, from not mastering (Non-Master) to mastering (Master) for all the skills tested.

IV. DISCUSSION

The role of technology in education needs to be perceived as a driving force in promoting a more effective learning process. Learning means the process of acquiring new knowledge and skills that indirectly will change the behaviour of an individual. Teaching and learning methods using robotic modules were interventions in this study. During robotic implementation, students were encouraged to freely and independently planning and designing investigation such as task allocation and selection, installing and programming a robot (Sullivan, 2008). They were also allowed to make modifications to the work methods rather than following the ones specified in the module (Shih, Chen, Wang, & Chen, 2013). Indeed, intensive exposure of a program or teaching module increases the effectiveness of learning and teaching. In carrying out robotic tasks, a few methods were utilized by students such as discussion and exploration of ideas. Throughout the implementation of robotics in the learning Physics course, opportunities for nurturing integrated science process skills were embedded (Williams, Ma, Prejean, & Ford, 2007). However, these opportunities were not explicitly stated as they were not planned but planning to convey the contents of the concepts and facts in the teaching existed. Hence, the inculcation of science process skills was developed indirectly during the activities provided by this robotic module.

The findings showed that almost all of integrated science process skills as measured by the study were improved after the intervention. The findings also showed that this intervention mostly nurtured the skills to identify variables. This improvement was also due to the encouragement given by the teaching method and materials as well as robotic modules. Thus, putting appropriate teaching and learning materials into practice will increase students' of integrated science process skills in general and in particular (Barak & Zadok, 2009). Therefore, learning through robotics also supported the enhancement of students of integrated science process skills (Alimisis & Boulougaris, 2014). This proved that the process of doing task independently will enable the absorption of information more effectively. It even strengthened their understanding.

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V. CONCLUSION

The findings as a whole confirmed that the teaching strategies using robotic modules on Form Four pupils, based on the project proposed by researchers, enhanced the integrated science process among them. Teaching and learning using robotic modules successfully facilitated students in exploring and investigating new knowledge. As a result, the instilment of integrated science process skills is observed through this TIPS 2 test. In this regard, Physics teachers, especially in the planning of teaching and learning processes, need to plan ahead an alternative learning process that involves the optimum exploitation of robotics. Thus, the responsible party requires formulating appropriate mechanisms to improve the readiness of teachers and among fully residential students to employ the learning approach which has been proven through the study.

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